

07/20/00
00698

BIRCH, STEWART, KOLASCH & BIRCH, LLP

INTELLECTUAL PROPERTY LAW
8110 GATEHOUSE ROAD
SUITE 500 EAST
FALLS CHURCH, VA 22042-1210
U S A
(703) 205-8000

FAX (703) 205-8050
(703) 698-8590 (G IV)

e-mail: mailroom@bskb.com
web: http://www.bskb.com

CALIFORNIA OFFICE:
COSTA MESA, CALIFORNIA

OF COUNSEL:
HERBERT L. BIRCH (1905-1996)
ELLIOT A. GOLOBERG
WILLIAM L. GATES¹
EDWARD H. VALANCE
RUFUS W. WYCKOFF ("RET")
P. PRINCE BUTLER
FRED S. WHISENHUNT

¹ADMITTED TO A BAR OTHER THAN VA

THOMAS S. AUCHTERLONIE
JAMES T. ELLER JR.
ROBERT LOVE
MARK J. NUELE, Ph.D.
D. RICHARD ANDERSON
JOHN R. BROWN
MARK W. MILSTEAD²
JOHN CAMPAGNA
RICHARD J. GALLAGHER
REG. PATENT AGENTS
FREDERICK R. HANOREN
CHRISTOPHER R. ARMSTRONG, Ph.D.
MAKI HATSUMI
MIKE S. RYU
CRAIG A. McDOWBIE
JAMES D. MCNAUL, Ph.D.
LAURA C. LUTZ
ROBERT E. GOONZER, Ph.D.
HYUN-JAE SOHN
MATTHEW J. FITTS
ALAN PEDERSEN-GILES
JUSTIN D. KARAJALA
MICHAEL J. MCGINNIS
TIMOTHY R. WYCKOFF
HERMES M. SOYEZ, Ph.D.
KRISTIS RUPERT, Ph.D.

JCS42 US PTO
09 62181
07/20/00

Date: July 20, 2000
Docket No.: 3430-0126P

Assistant Commissioner for Patents
Box PATENT APPLICATION
Washington, D.C. 20231

Sir:

As authorized by the inventor(s), transmitted herewith for filing
is a patent application applied for on behalf of the inventor(s)
according to the provisions of 37 CFR 1.41(c).

Inventor(s): LEE, Dong-Hoon

For: TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

Enclosed are:

- A specification consisting of 12 pages
- 4 sheet(s) of formal drawings
- Certified copy of Priority Document(s)
- Executed Declaration in accordance with 37 CFR 1.64 will follow
- A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27
- Preliminary Amendment
- Information Sheet
- Information Disclosure Statement, PTO-1449 with reference(s)

Other _____

The filing fee has been calculated as shown below:

FOR	NO. FILED	NO. EXTRA	LARGE ENTITY		SMALL ENTITY	
			RATE	Fee	RATE	Fee
BASIC FEE	***** ***** *****	***** ***** *****	***** ***** *****	\$690.00	or ***** ***** *****	\$345.00
TOTAL CLAIMS	5 - 20 =	0	x18 = \$	0.00	or x 9 = \$	0.00
INDEPENDENT	1 - 3 =	0	x78 = \$	0.00	or x 39 = \$	0.00
MULTIPLE DEPENDENT CLAIM PRESENTED	no		+260 = \$	0.00	or +130 = \$	0.00
			TOTAL \$	690.00	TOTAL \$	0.00

The application transmitted herewith is filed in accordance with 37 CFR 1.41(c). The undersigned has been authorized by the inventor(s) to file the present application. The original duly executed patent application together with the surcharge will be forwarded in due course.

A check in the amount of \$ 690.00 to cover the filing fee and recording fee (if applicable) is enclosed.

The Government Filing Fee will be paid at the time of completion of the filing requirement.

Please charge Deposit Account No. 02-2448 in the amount of \$ _____. A triplicate copy of this transmittal form is enclosed.

Send Correspondence to: BIRCH, STEWART, KOLASCH & BIRCH, LLP
P. O. Box 747
Falls Church, Virginia 22040-0747

No fee is enclosed.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. 1.16 or under 37 C.F.R. 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By

TERRI L. CLARK
Reg. No. 32,644
P. O. Box 747
Falls Church, Virginia 22040-0747

(703) 205-8000
TLC/amr

Transflective Liquid Crystal Display Device

Cross Reference

This application claims the benefit of Korean Patent Application No. 1999-29221, filed on July 20, 1999, under 35 U.S.C. § 119, the entirety of which is hereby incorporated by reference.

Background

Field of the invention

The present invention relates to a liquid crystal display (LCD) device, and more particularly, to a transflective LCD device.

|

Description of Related Art

In general, liquid crystal displays are divided into transmissive LCD devices and reflective LCD devices according to whether the display uses an internal or an outer light source.

A typical transmissive LCD device comprises a liquid crystal panel and a back light device. The liquid crystal panel includes upper and lower substrates with a liquid crystal layer interposed therebetween. The upper substrate has a color filter, and the lower substrate has a thin film transistor (TFT) as a switching element. An upper polarizer is arranged on the upper substrate of the liquid crystal panel, and a lower polarizer is arranged between the lower substrate of the liquid crystal panel and the backlight device.

At this time, the two polarizers have a transmittance of 45%, the two substrates have a transmittance of 94%, the TFT array and the pixel have a transmittance of 65%, and the color filter has a transmittance of 27%, respectively. Therefore, the transmissive LCD device gets to have about a transmittance of 7.4% as seen in Fig. 1 which shows a transmittance after light passes through each layers. For such a reason, the transmissive

LCD device requires a high brightness and thus an electric power consumption by the backlight device increases. In order to supply a sufficient power to the backlight device, a relatively heavy battery is employed, and there still exists a problem that the battery can not be used for a long time.

In order to overcome the problem described above, the reflective LCD has been developed. Since the reflective LCD device uses ambient light, it is easy to carry. Also, the reflective LCD device is superior in aperture ratio than the transmissive LCD device.

Fig. 2 is a plan view illustrating a typical reflective LCD device. As shown in Fig. 2, the reflective LCD device 100 includes gate lines 6 and 8 arranged in a transverse direction, data lines 2 and 4 arranged in a longitudinal direction perpendicular to the gate lines 6 and 8, and thin film transistors "S" (TFTs) near cross points of the gate line 8 and the data line 2. Each of the TFTs "S" has a gate electrode 18, a source electrode 12 and a drain electrode 14. The data electrode 18 extends from the data line 2, and the gate electrode 18 extends from the gate line 8. The reflective LCD device 100 further includes reflective electrodes 10. The reflective electrode 10 is electrically connected with the drain electrode 14 through a contact hole 16 and is made of a metal having a good reflectance.

By the way, the reflective LCD device has a problem that it is affected by its surroundings. For example, the brightness of ambient light in an office differs largely from that of the outdoors. Also, even in the same location, the brightness of ambient light depends on the time of day (e.g., noon or dusk).

In order to overcome the problem described above, a transflective LCD device has been developed. Fig. 3 shows a conventional transflective LCD device. As shown in

Fig. 3, the conventional transflective LCD device includes lower and upper substrates 50 and 60 with a liquid crystal layer 80 interposed therebetween. The upper substrate 60 has a color filter 61, and the lower substrate 50 has a switching element (not shown), a pixel electrode 54 and a reflective electrode 52. The reflective electrode 52 is made of a opaque conductive material having a good reflectance and includes light transmitting holes 53 formed therein. The transflective LCD device further includes a backlight device 70. The light transmitting holes 53 serve to transmit light 112 from the backlight device 16.

The transflective LCD device is operable in both a transmissive mode and a reflective mode. First, in the reflective mode, the incident light 74 from the upper substrate 22 is reflected on the reflective electrode 52 and directs toward the upper substrate 22 again. At this time, when the electrical signals are applied to the reflective electrode 52 by the switching element (not shown), phase of the liquid crystal layer 80 varies and thus the reflected light is colored by the color filter 61 and displayed in the form of colored light.

Further, in the transmissive mode, light 72 generated from the backlight device 70 passes through portions of the pixel electrode 54 corresponding to the transmitting holes 53. At this time, when the electrical signals are applied to the pixel electrode 54 by the switching element (not shown), phase of the liquid crystal layer 80 varies. Thus, the light 72 passing through the liquid crystal layer 80 is colored by the color filter 61 and displayed in the form of images with other colored lights.

As described above, since the transflective LCD device has both the transmissive mode and the reflective mode, the transflective LCD device can be used without depending on the time of day (e.g., noon or dusk) and has advantages that it can

be used for a long time with consuming a low power.

However, since the reflective electrode 52 has a plurality of the transmitting holes 53, the conventional transflective LCD device has a very low light utilizing efficiency compared to the reflective LCD device or the transmissive LCD device. For example, it should be noted that the number of the circular-shaped light transmitting hole 53 having a diameter of ΔL is "n". an area of one light transmitting hole 53 is " $(\pi \Delta L^2)/4$ ", and thus a total area of all light transmitting holes 53 gets to be " $n \times (\pi \Delta L^2)/4$ ". As a result, the light utilizing efficiency of the transmissive mode and that of the reflective mode are in inverse proportion according to the total area of the light transmitting holes 53. In other words, if a total area of the light transmitting holes 53 is reduced in order to increase the light utilizing efficiency in the reflective mode, in proportion to the reduced area of the holes 53, the light utilizing efficiency in the transmissive mode gets to be reduced.

For the foregoing reasons, there is a need for a transflective LCD device having a good utilizing efficiency in both the transmissive mode and the reflective mode.

SUMMARY OF THE INVENTION

To overcome the problems described above, preferred embodiments of the present invention provide a transflective LCD device having a good utilizing efficiency in both the transmissive mode and the reflective mode.

More particularly, the preferred embodiments of the present invention provide a transflective LCD device having a good utilizing efficiency in the reflective mode.

In order to achieve the above object, the preferred embodiment of the present invention provides a transflective liquid crystal display device, including a liquid crystal

display panel , a transflective film, and a backlight device. The liquid crystal display panel has a first transparent substrate, a second transparent substrate, and a liquid crystal layer interposed between the first and second transparent substrates. The first transparent substrate has a color filter and the second transparent substrate having a pixel electrode and a reflector. The reflector has a light transmitting hole which the pixel electrode covers. The light transmitting hole transmits light. The transflective film is located outside of the second transparent substrate of the liquid crystal display panel around a location corresponding to the light transmitting hole. The transflective film is made of a transmissive material with reflective material scattered on the upper surface of the transmissive material. The reflective material reflects light, and the transmissive material transmits light. The back light device supplies light toward the transflective film.

The reflective material of the transflective film is selected from a group consisting of Ag and Al, and the transmissive material of the transflective film is an acrylic-based resin. The reflector is made of an opaque conductive material, and the pixel electrode is made of indium tin oxide (ITO)

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

Fig. 1 is a graph illustrating a transmittance after light passes through each layers of a conventional liquid crystal display device;

Fig. 2 is a plan view illustrating a conventional reflective liquid crystal display device;

Fig. 3 is a cross-sectional view illustrating a conventional transflective liquid crystal display device;

Fig. 4 is a plan view illustrating the conventional transflective liquid crystal display device of Fig. 3;

Fig. 5 is a cross-sectional view illustrating a transflective liquid crystal display device according to a preferred embodiment of the present invention,

Fig. 6 is a front view illustrating a structure of a transflective film according to the preferred embodiment of the present invention; and

Fig. 7 is a plan view illustrating an exemplary structure of a reflective electrode of the transflective liquid crystal display device according to the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiment of the present invention, example of which is illustrated in the accompanying drawings.

Fig. 5 is a cross-sectional view illustrating a transflective liquid crystal display device according to a preferred embodiment of the present invention. As shown in Fig. 5, a transflective liquid crystal display device according to a preferred embodiment of the present invention includes a liquid crystal display panel and a back light device 108. The liquid crystal display panel includes lower and upper substrates 100 and 112 with a liquid crystal layer 110 interposed therebetween. The upper substrate 112 has a color filter 111, and the lower substrate 100 has a switching element (not shown), a pixel

electrode 104 and a reflective electrode 102. The reflective electrode 102 is made of an opaque conductive material having a good reflectance and includes light transmitting holes 103 formed therein. The pixel electrode is made of a transparent conductive material such as indium tin oxide (ITO), and may be located on or under the light transmitting holes 103, overlapping a portion of the reflective electrode 102. The transflective LCD device further includes a transflective film 106 arranged between the lower substrate 100 and the back light device 108. The light transmitting holes 103 serve to transmit light 130 from the backlight device 108. The transflective LCD device further includes an upper polarizer (not shown) on the upper substrate 112 and a lower polarizer (not shown) located between the lower substrate 100 and the transflective film 106.

The transflective film 106, as shown in Fig. 6, has a reflective portion 106a on the upper surface thereof and a transmissive portion 106b. In other words, the reflective materials 106a are scattered on the upper surface of the transmissive material 106b. However, the reflective materials 106a may be scattered in the inner surface of the transmissive material 106b. It is preferred that the reflective portion 106a is made of a reflective material such as Ag and Al and that the transmissive portion 106b is made of an acrylic-based resin. That is, the transflective film 106 is made of the acrylic-based resin on which the reflective materials are scattered. The reflective portion 106a made of Ag and Al serves to reflect the incident light 132 from the outside along with the reflective electrode 102 in the reflective mode. The transmissive portion 106b serves to transmit the light 130 from the backlight device 108 in the transmissive mode.

Further, a concentration of the reflective material 106a scattered on the upper surface of the acrylic-based resin 106b is adjustable. Therefore, since the LCD devices

for use in a mobile phone, a personal digital assistants (PDA) and a portable notebook computer uses the reflective mode as a main mode, by increasing an amount of the reflective material 106a scattered on the acrylic-based resin 106b, the transflective LCD device having the reflective mode as the main mode can be manufactured. Alternatively, by decreasing an amount of the reflective material 106a scattered on the acrylic-based resin 107b, the transflective LCD device having the transflective mode as the main mode can be manufactured.

The transflective LCD device described above is operated as follows. First, in the reflective mode, the incident light 132 from the upper substrate 112 is reflected on the reflective electrode 102 and the reflective portion 106a of the transflective film 106, and then directs toward the upper substrate 112 again. That is, since the incident light 132 from the outside is reflected on the reflective portion 106a of the trnasflective film 106 as well as the reflective electrode 102, an aperture ratio and the light utilizing efficiency in the reflective mode are much improved.

Further, in the transmissive mode, light 130 from the backlight device 70 passes through the transmissive portion 106b of the transflective film 106 and a portion of the pixel electrode 54 corresponding to the transmitting holes 103. That is, if it is noted that the diameter of the light transmitting holes 103 is same as that of the conventional art shown in Fig. 4, an aperture ratio gets to be same as that of the conventional art.

Furthermore, when the transmissive mode and the reflective mode are operated at the same time, the transflective LCD device can have a better light utilizing efficiency. For example, when the transflective LCD device is used in dusk room in which a brightness of light is bad more or less, the user can operate the transmissive

mode and the reflective mode at the same time and thus the light utilizing efficiency can be improved remarkably.

The light transmitting holes 103 may have a circular shape, a rectangular shape as shown in Fig. 7 or other shapes. The light transmitting holes 103 formed in the reflective electrode 102 does not have a limitation to its size and its location. For example, the light transmitting holes 103 separated from the reflective electrode 102 may be formed.

As described above, using the transflective LCD device according to the preferred embodiment of the present invention, since an amount of the transmitted or reflected light can be controlled by increasing or decreasing an amount of the reflective material contained in the acrylic-based resin of the transflective film, the light utilizing efficiency in the reflective mode or the transflective mode can be much improved. More particularly, the transflective LCD device having a good utilizing efficiency in the transmissive mode can be obtained. Further, the transflective LCD device having the reflective mode or the transflective mode as the main mode can be easily manufactured.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A transflective liquid crystal display device, comprising:
a liquid crystal display panel having a first transparent substrate, a second transparent substrate, and a liquid crystal layer interposed between the first and second transparent substrates, the first transparent substrate having a color filter, the second transparent substrate having a pixel electrode and a reflector, the reflector having a light transmitting hole which the pixel electrode covers, the light transmitting hole transmitting light;

a transflective film located outside of the second transparent substrate of the liquid crystal display panel around a location corresponding to the light transmitting hole, made of a transmissive material with reflective material scattered therein, the reflective material reflecting light, the transmissive material transmitting light; and

a back light device for supplying light toward the transflective film.

2. The transflective liquid crystal display device of claim 1, wherein the reflective material of the transflective film is selected from a group consisting of Ag and Al.

3. The transflective liquid crystal display device of claim 1, wherein the transflective material of the transflective film is an acrylic-based resin.

4. The transflective liquid crystal display device of claim 1, wherein the reflector is made of an opaque conductive material.

5. The transreflective liquid crystal display device of claim 1, wherein the pixel electrode is made of indium tin oxide (ITO).

ABSTRACT OF THE DISCLOSURE

The present invention discloses A transreflective liquid crystal display device, including: a liquid crystal display panel having a first transparent substrate, a second transparent substrate, and a liquid crystal layer interposed between the first and second transparent substrates, the first transparent substrate having a color filter, the second transparent substrate having a pixel electrode and a reflector, the reflector having a light transmitting hole which the pixel electrode covers, the light transmitting hole transmitting light; a transreflective film located outside of the second transparent substrate of the liquid crystal display panel around a location corresponding to the light transmitting hole, made of a transmissive material with reflective material scattered thereon, the reflective material reflecting light, the transmissive material transmitting light; and a back light device for supplying light toward the transreflective film.

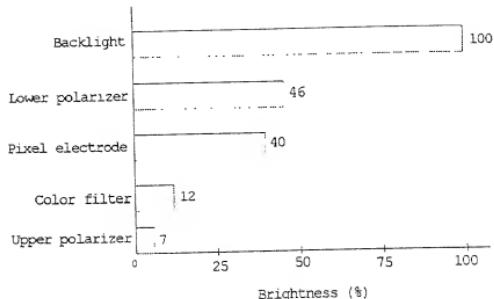


FIG.1

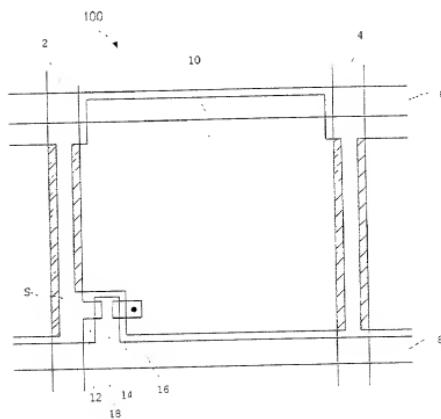
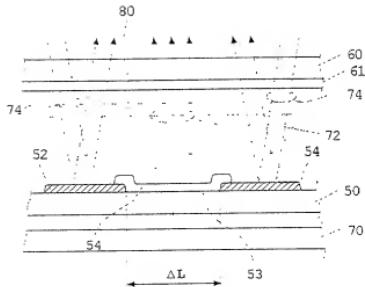
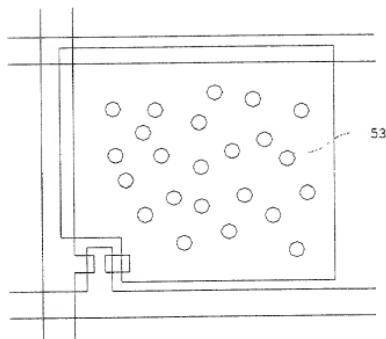


FIG.2



(RELATED ART)

FIG. 3



(RELATED ART)

FIG. 4

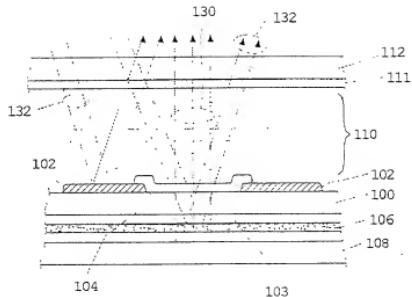


FIG.5

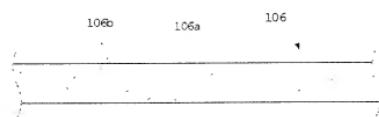


FIG.6

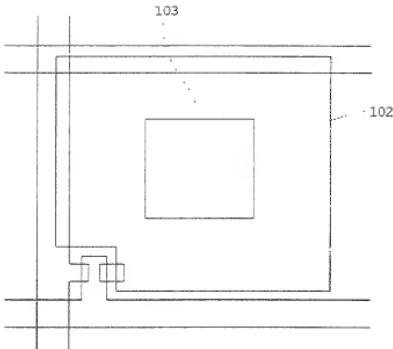


FIG. 7